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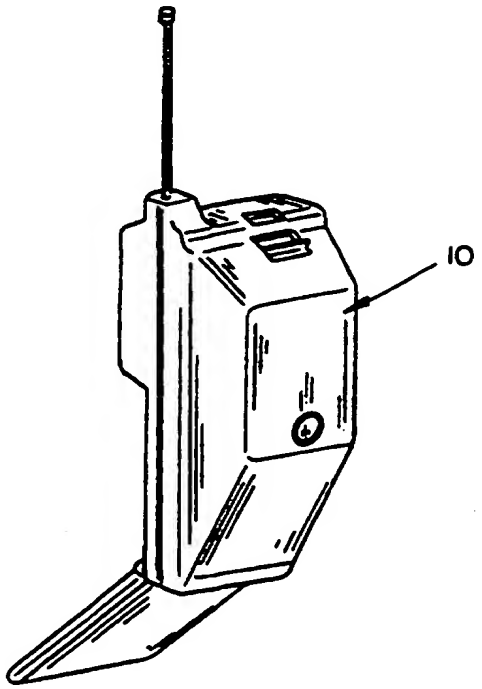
(54) Title: A VENTILATED BATTERY HOUSING FOR USE WITH RECHARGEABLE BATTERY CELLS

(57) Abstract

A ventilated battery housing for use with rechargeable battery cells comprising a vent opening formed in the battery housing which is either covered or closed by a member which permits hydrogen gas to escape from the interior of the battery but which prevents water and/or dust from passing therethrough into the interior of the battery housing.



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TITLE: **A VENTILATED BATTERY HOUSING FOR USE WITH RECHARGEABLE BATTERY CELLS**

Background of the Invention

1. Field of the Invention

This invention relates to a ventilated housing for a battery and more particularly to a ventilated battery housing for use with nickel-metal hydride cells.

2. Description of the Prior Art

Current battery technology seems to be moving to the nickel-metal hydride type of batteries. The use of the nickel-metal hydride batteries has raised concerns from the cell manufacturers with regard to the safety of a completely sealed battery housing. These concerns arise from a possibility of hydrogen gas venting from nickel-metal hydride cells in an overcharge situation.

In a nickel-metal hydride cell, hydrogen gas recombines at the negative electrode during charging. Once the cell is fully charged, any additional hydrogen that is generated during overcharge cannot efficiently recombine and pressure begins to build inside the cell. If the pressure exceeds the pressure setting of the cell's safety valve, the valve actuates thereby releasing the excess hydrogen. If sufficient gas is not dissipated, as in an enclosed battery pack, the potential exists for the battery to explode, providing an ignition source is present. The possibility of venting of nickel-metal hydride cells only occurs if the cells overcharge at a rate greater than 0.3C.

The cell manufacturers have begun to require that their customers design a battery pack having a certain amount of open surface area in the housing to permit the hydrogen to escape, or the battery to "breathe" in the event of an overcharge condition. This becomes a problem in applications where the battery must be water/dust/immersion proof.

According to Factory Mutual Research Corporation ("FMRC"), the most explosive mix of hydrogen gas in air is 21%. FMRC has found that if the hydrogen mix remains below 3%, the possibility of an explosion disappears. Maintaining the mix below 3% requires that the hydrogen gas has some way of exhausting to the outside atmosphere. Current open surface area battery designs normally hide the openings where the battery mates to the radio. This gives the battery a more aesthetic appearance, but the escaping hydrogen gas is very likely to collect inside the radio itself which actually increases the likelihood of an explosion due to the concentration of electronics nearby which could act as an ignition source.

Summary of the Invention

A ventilated battery housing is provided for use with nickel-metal hydride cells. The nickel-metal hydride battery includes a battery housing having one or more battery cells therein. The housing has a vent means for venting hydrogen from the interior thereof while preventing water and dust from entering the interior of the housing. In one form of the invention, the vent means comprises an umbrella valve which opens when a pre-determined amount of internal pressure is sensed. In another embodiment, the vent means comprises a duckbill valve. In yet another embodiment, the vent means comprises a vent opening formed in the housing and which has a porous plastic material extending thereover. In yet another embodiment, the vent means comprises a vent opening formed in the housing having a GORE-TEX® material extending thereover. In yet another embodiment of the invention, the vent means comprises a vent opening formed in the housing and which has a sintered metal material positioned therein. In still another embodiment of the invention, the vent means comprises a vent opening formed in the battery housing and which has a breathable label extending thereover.

It is th refore a principal object of the invention to provide a means for venting a battery housing having one or more nickel-metal hydride battery cells therein.

Still another object of the invention is to provide a means for venting a battery housing having one or more battery cells therein.

Still another object of the invention is to provide a battery housing having a vent means associated therewith which permits explosive gases to escape from the interior thereof while preventing water and dust from entering the interior of the housing.

Still another object of the invention is to provide a device of the type described that is aesthetically pleasing.

Still another object of the invention is to provide a device of the type described which does not interfere with the normal operation of the radio, cellular telephone or other battery powered device.

These and other objects of the present invention will be apparent to those skilled in the art.

Brief Description of the Drawings

Figure 1 is a perspective view of a cellular telephone having a ventilated battery housing of this invention mounted thereon;

Figure 2 is an exploded perspective view of an umbrella valve used for venting the battery housing;

Figure 3 is a sectional view of the umbrella valve of Figure 2;

Figure 4 is an exploded perspective view of a vent embodiment wherein a duckbill valve is utilized;

Figure 5 is a sectional view of the duckbill valve of Figure 4;

Figure 6 is an exploded perspective view of yet another embodiment of the vent wherein a porous plastic material is utilized;

Figure 7 is a sectional view of the embodiment of Figure 6 which illustrates a plastic ring being moved downwardly to entrap the porous plastic material;

Figure 8 is a sectional view of the embodiment of Figures 6 and 7;

Figure 9 is an exploded perspective view of yet another embodiment of the invention wherein GORE-TEX® material is trapped between a circular plastic ring and the battery housing;

Figure 10 is ` sectional view of the embodiment of Figure 9 illustrating the plastic ring being positioned above the GORE-TEX® membrane prior to the attachment thereto;

Figure 11 is a sectional view of the embodiment of Figures 9 and 10;

Figure 12 is an inside perspective view of yet another embodiment of the ventilated housing;

Figure 13 is an inside perspective view of the embodiment of Figure 12;

Figure 14 is a sectional view of the embodiment of Figures 12 and 13;

Figure 15 is an exploded perspective view of yet another embodiment of the vent;

Figure 16 is a sectional view of the embodiment of Figur 15;

Figure 17 is an inside perspective view of yet another embodiment of the invention: and

Figure 18 is a sectional view of the embodiment of Figure 17.

Description of the Preferred Embodiment

In the drawings, the numeral 10 refers to a battery housing such as would be used with a two-way radio, cellular telephone, notebook computer, power tool or other battery powered device, etc. One form of the ventilated battery is illustrated in Figures 2 - 3. In the embodiment of Figures 2 - 3, the battery housing 10 is provided with a plurality of vent openings 12 which extend through the housing 10. An

opening 14 is provided in the housing 10 between the openings 12 which is adapted to receive the shank 16 of an umbrella valve 18 as illustrated in Figure 2. Preferably, umbrella valve 18 is comprised of a flexible rubber/elastomer material. Umbrella valve 18 includes a dome portion 20 provided at one end of the shank portion 16, the periphery of which is adapted to engage the housing 10 outwardly of the openings 12 as illustrated in Figure 3. Normally, the dome portion 20 seals the vent openings 12 to prevent water and/or dust from entering the interior of the battery housing. In the event of hydrogen discharge from the cells, the internal pressure in the battery causes the dome portion 20 to open slightly allowing the hydrogen to escape to the atmosphere. The cracking pressure of a typical valve would be approximately 0.1 PSI. After releasing the pressure, the dome portion 20 of the valve 18 then reseals against the battery housing.

Another embodiment of the invention is illustrated in Figures 4 - 5. Battery housing 10 is provided with a vent opening 22 formed therein which has a duckbill valve 24 positioned therein. Duckbill valve 24 includes a movable valve portion 26 which is normally closed to seal the interior of the battery housing to prevent dust and water from entering the interior thereof but which opens in the event of a hydrogen discharge from the cells. After the pressure within the cells has been released, the valve member 26 again reseals to close the interior of the battery housing.

Yet another embodiment of the invention is illustrated in Figures 6 - 8 wherein the housing 10 is provided with a vent opening 28 which is closed by a porous plastic material referred to generally by the reference numeral 30 and which is held in the vent opening 28 by a plastic ring 32. Porous plastic material 30 is trapped between the circular plastic ring 32 and the housing of the battery and would preferably be ultrasonically welded to the plastic battery housing. Preferably, the plastic ring 32 is comprised of the same

material as the battery housing and will be flush with the outside of th battery housing after installation as illustrated in Figure 8. The porous plastic material 30 will not allow water to enter the battery housing but will prevent the escape of hydrogen gas to the atmosphere in the event that the battery is overcharged. With the inside of the battery essentially "open" to the outside atmosphere, a certain `mount of air flow would exist inside the battery which will help to dissipate the hydrogen to the atmosphere. A suitable type of porous plastic material would be POREX®.

Still another embodiment of the invention is illustrated in Figures 9 - 11 wherein a vent opening 24 is formed in the battery housing 10 and which is closed by a GORE-TEX® membrane material 35 which is trapped between a circular plastic ring 36 and the housing of the battery. Ring 36 is preferably ultrasonically welded to the plastic battery housing 10 and would be comprised of the same material as the battery housing. The plastic ring 36 is also preferably flush with the outside of the battery housing 10 after installation. The GORE-TEX® membrane material 35 will not allow water or dust to enter the battery housing but will allow the escape of hydrogen gas to the atmosphere in the event that the battery is overcharged. With the inside of the battery essentially "open" to the atmosphere, a certain amount of airflow will exist inside the battery which will help to dissipate the hydrogen to the atmosphere.

Yet another method of using GORE-TEX® membranes in conjunction with the vent opening is to create a series of openings in the battery housing such as a grille 38 as illustrated in Figures 12 - 14 which is provided in the housing 10. The openings of the grille 38 are covered with GORE-TEX® material 39 and sealed via ultrasonic welding, hot stamping, adhesives, or some other means. The size, number and location of the ventilating elements such as illustrated in Figures 12 - 14 will be dictated by the number and size of cells in the battery, the charge/discharge parameters, and the operating environment.

Yet another means of providing a ventilated battery housing is illustrated in Figures 15 - 16 wherein a vent opening 40 formed in the battery housing 10 is closed by a sintered metal disk or plug 42. Preferably, the sintered metal disk is comprised of a sintered bronze material which permits the passage of gas therethrough but which prevents dust or water from passing therethrough. Although a sintered bronze material is preferred, other types of metal materials may be used which achieve the same results such as aluminum, stainless steel, etc. The plug 42 is preferably manufactured from a porous material in which the material, particle size, porosity volume, pore size, pore shape, tortuosity and interconnection of the pores is such that the plug will readily allow the passage of gas therethrough but will not allow the passage of fine debris and liquid such as water. This ability is the result of one or more of the following characteristics of a structure:

(1) A pore structure such that "cake formation" filtration occurs;

(2) A pore structure such that internal trapping or "depth filtration" occurs; and

(3) A pore structure such that the liquids to be eliminated will have a large contact angle with the pore structure and material and cause them to be non-wetting liquids and not to be drawn into the housing 10 by capillary action.

Still another embodiment of the invention is illustrated in Figures 17 - 18 wherein a plurality of vent openings 44 are formed in the battery housing 10. A breathable label 46 preferably comprised of a suitable plastic material such as olefin is preferably secured to the interior surface of the battery housing 10 so as to cover the vent openings 44 as illustrated in Figures 17 and 18. The breathable label 46 may also be positioned on the exterior of housing 10 if so desired. The breathable label 46 permits the hydrogen gas to escape therethrough in the event that the battery is overcharged. The breathable label 46 also permits air to

flow inside the battery thus reducing the hydrogen concentration inside the battery while still preventing the passage of water or dust into the interior of the battery. One type of material which may be used for the label 46 is olefin. One type of olefin would be TYVEK®.

Thus it can be seen that a novel ventilated battery housing has been provided for use with nickel-metal hydride cells. Although it is preferred that the ventilated battery housing be used with nickel-metal hydride cells, the ventilated battery housing could be used with other types of battery cells. The various embodiments disclosed herein permit the battery housing to breathe so that hydrogen gas may escape therefrom to prevent formation of dangerous explosive situations while preventing water and dust from entering the interior of the battery housing. The various embodiments disclosed herein may be easily incorporated into conventional battery housings without extensive modification thereof without interfering with the aesthetic appearance of the battery housing. Thus it can be seen that the invention accomplishes at least all of its stated objectives.

What is claimed:

1. In combination: a battery including a battery housing having one or more battery cells therein; said housing having vent means for venting gas from the interior thereof to the atmosphere while preventing water and/or dust from entering the interior of the housing.

2. The combination of claim 1 wherein said vent means comprises an umbrella valve.

3. The combination of claim 1 wherein said vent means comprises a duckbill valve.

4. The combination of claim 1 wherein said vent leans comprises a vent opening formed in said housing having a porous plastic material positioned therein.

5. The combination of claim 1 wherein said vent means comprises a vent opening formed in said housing having a GORE-TEX® material extending thereover.

6. The combination of claim 1 wherein said vent means comprises a vent opening formed in said housing having a porous metal material positioned therein.

7. The combination of claim 6 wherein said metal material is a sintered metal material.

8. The combination of claim 7 wherein said sintered metal material comprises a bronze material.

9. The combination of claim 1 wherein said vent means comprises a vent opening formed in said battery housing having a breathable label extending thereover.

10. In combination: a nickel-metal hydride battery including a battery housing having one or more battery cells therein; said housing having vent means for venting hydrogen from the interior thereof to the atmosphere while preventing water and/or dust from entering the interior of the housing.

11. The combination of claim 10 wherein said vent means comprises an umbrella valve.

12. The combination of claim 10 wherein said vent means comprises a duckbill valve.

13. The combination of claim 10 wherein said vent means comprises a vent opening formed in said housing having a porous plastic material positioned therein.

14. The combination of claim 10 wherein said vent means comprises a vent opening formed in said housing having a GORE-TEX® material extending thereover.

15. The combination of claim 10 wherein said vent means comprises a vent opening formed in said housing having a porous metal material positioned therein.

16. The combination of claim 15 wherein said metal material is a sintered metal material.

17. The combination of claim 16 wherein said sintered metal material comprises a bronze material.

18. The combination of claim 10 wherein said vent means comprises a vent opening formed in said battery housing having a breathable label extending thereover.

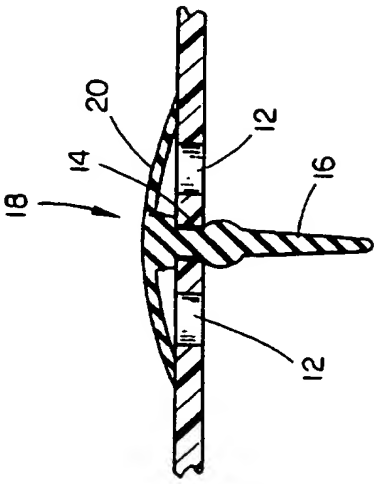

FIG. 3

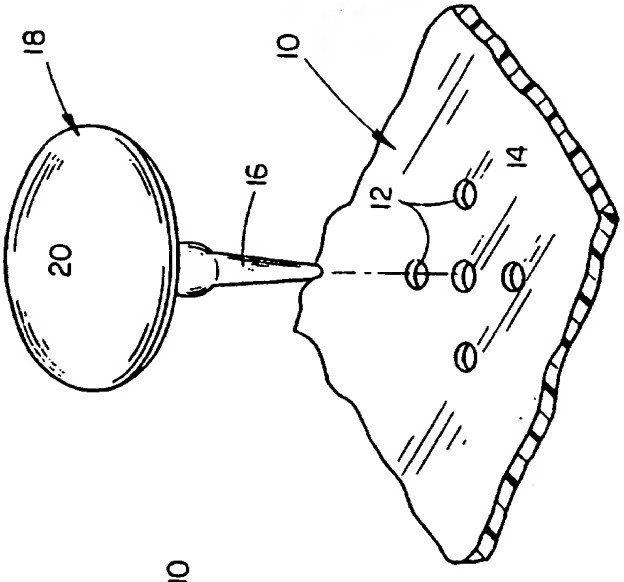

FIG. 2

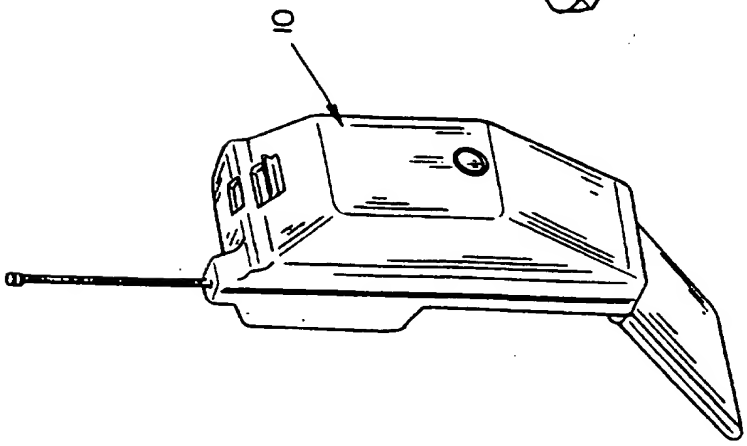

FIG. 1

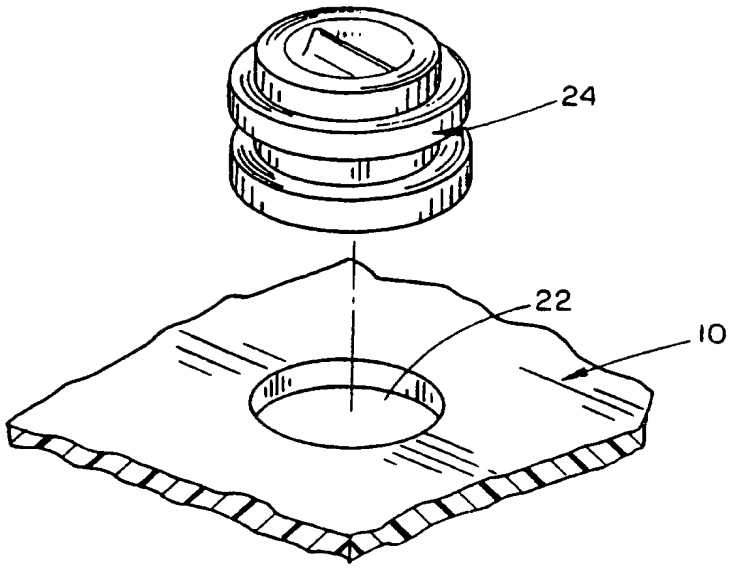

FIG. 4

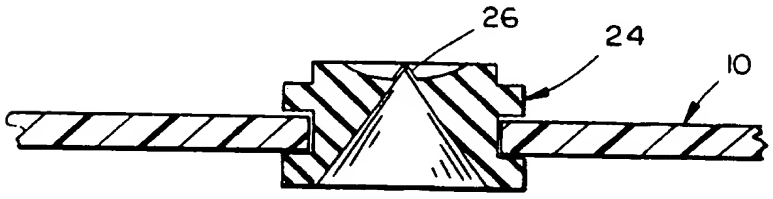

FIG. 5

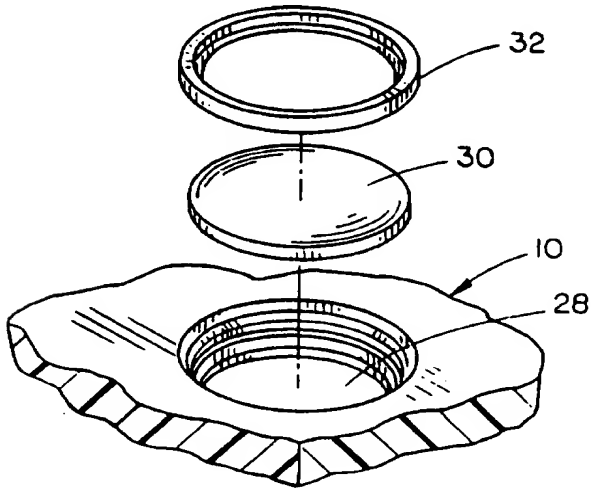

FIG. 6

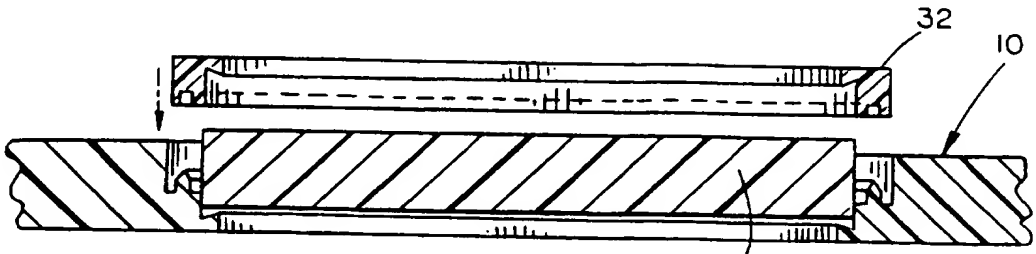

FIG. 7

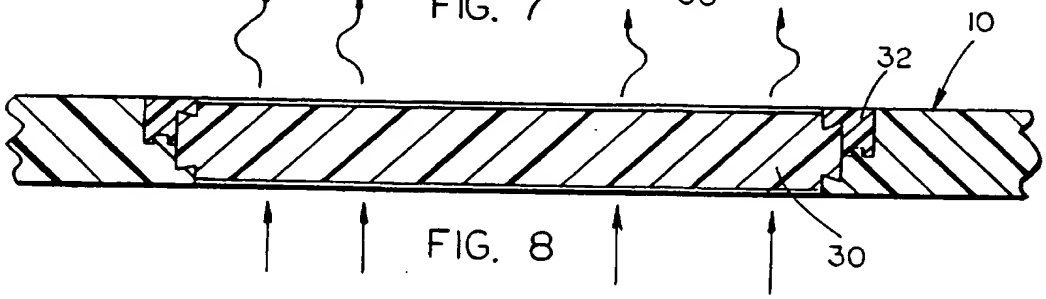

FIG. 8

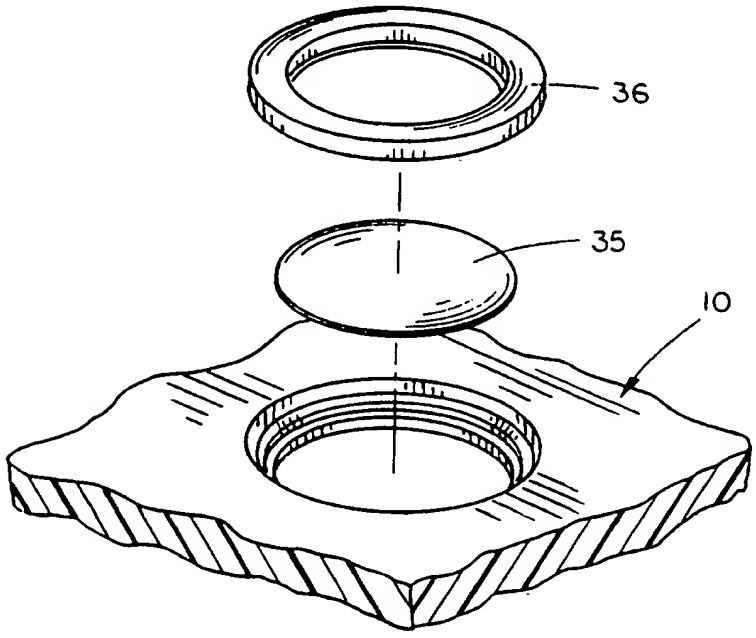

FIG. 9

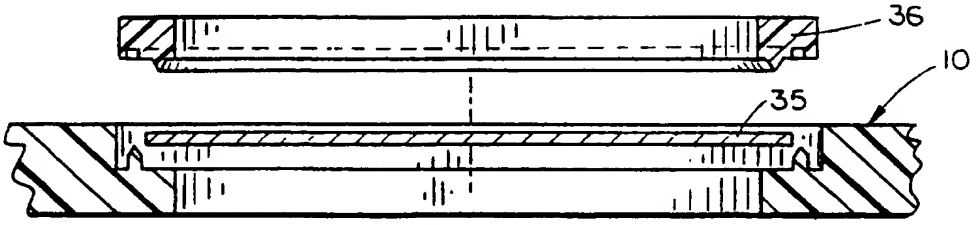

FIG. 10

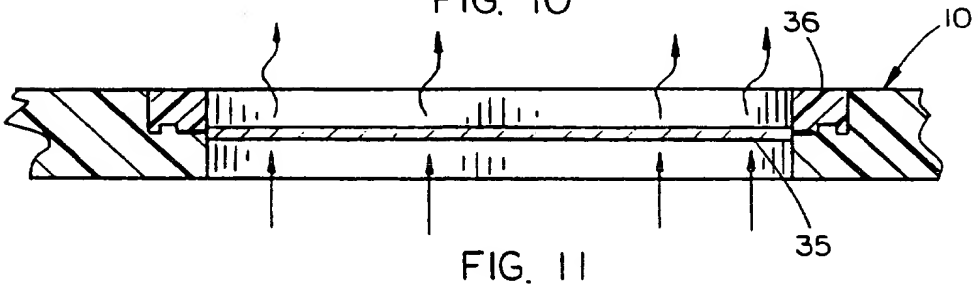

FIG. 11

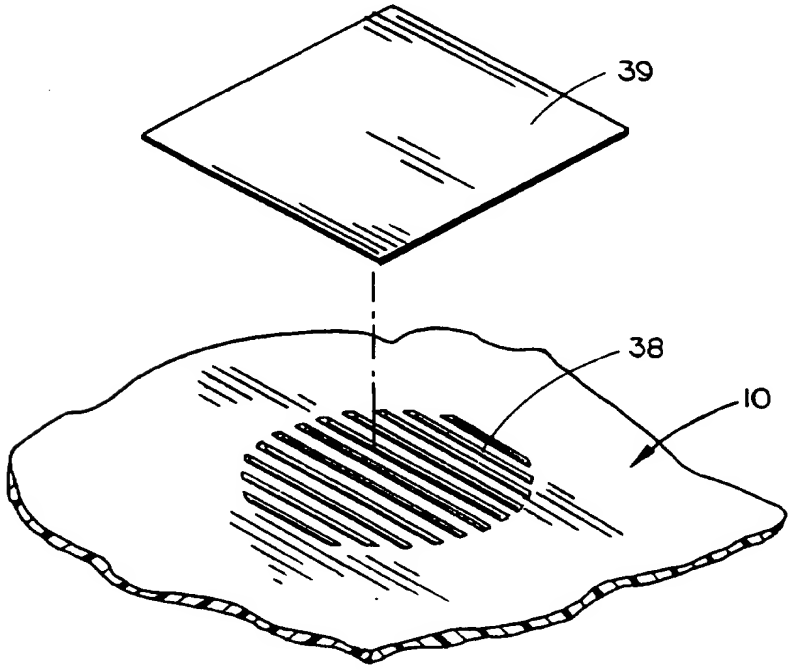

FIG. 12

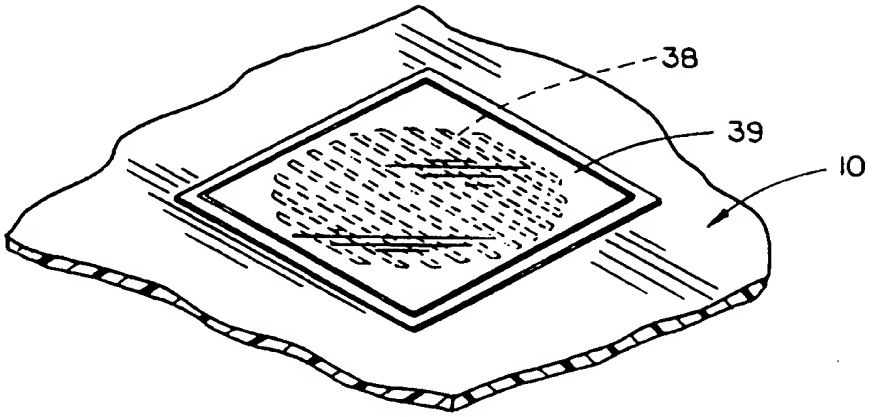

FIG. 13

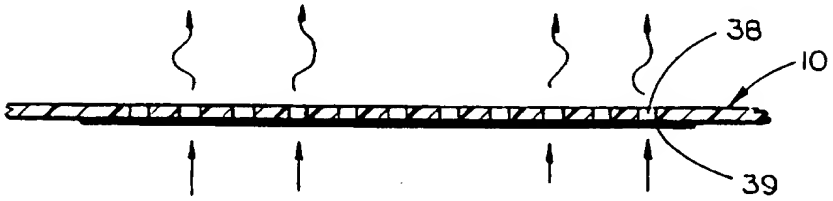

FIG. 14

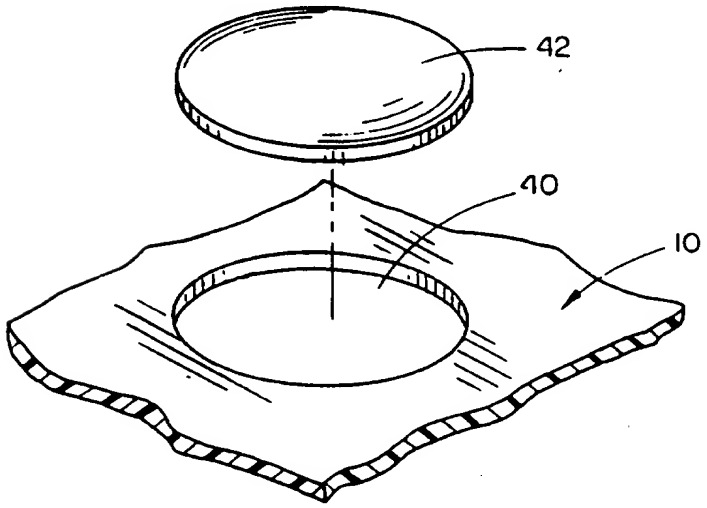

FIG. 15

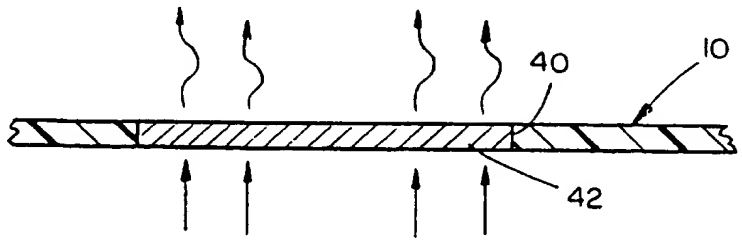

FIG. 16

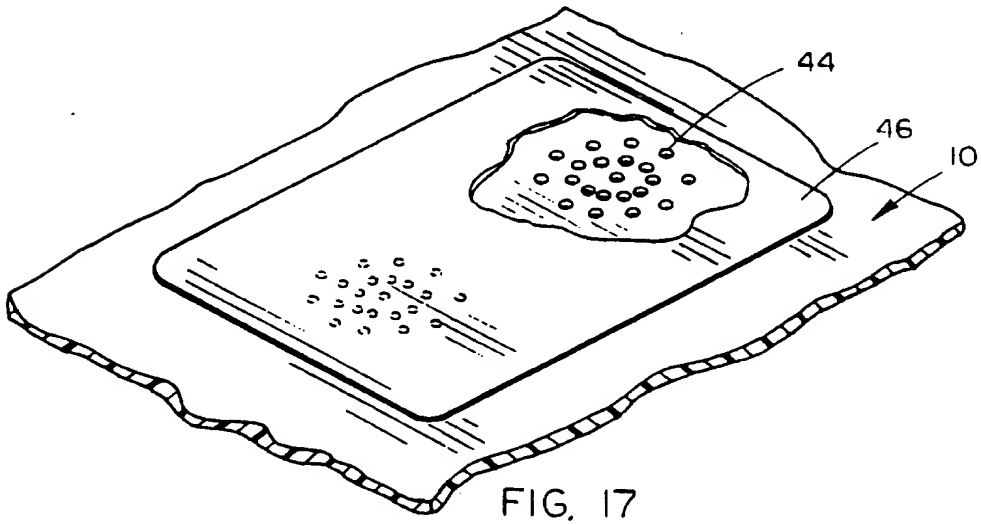

FIG. 17

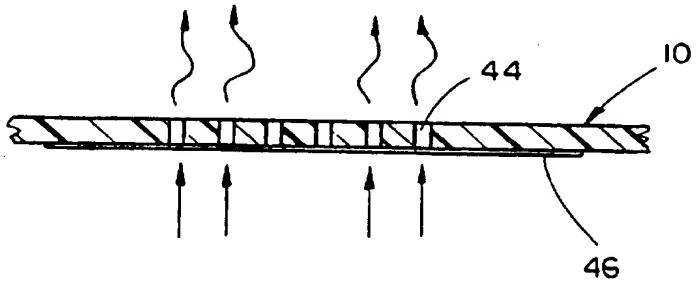

FIG. 18

INTERNATIONAL SEARCH REPORT

Inten. ...nal Application No
PCT/US 95/01054

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01M2/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,92 10005 (MOTOROLA INC) 11 June 1992 see page 2, line 3 - line 32; figure 2A see page 4, line 5 - line 36; claims 1,5,6	1,4-7
Y	---	8,9
Y	GB,A,1 095 499 (JOSEPH LUCAS) 20 December 1967 see claim 3	8

Y	US,A,4 194 061 (EDWIN H. LAND ET AL) 18 March 1980 see column 4, line 48 - line 54; figure 1	9

X	GB,A,2 021 306 (UNION CARBIDE CORP) 28 November 1979 see abstract see page 4, line 119 - line 129 see page 1, line 13 - line 30; claim 1	1,4,5

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 May 1995	06.06.95

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB,A,2 253 512 (MATSUSHITA ELECTRIC WORKS LTD) 9 September 1992 see page 7, line 23 - page 8, line 18; claims 1,2; figures 3,5	1,2
X	DE,A,37 31 724 (SANYO ELECTRIC CO) 24 March 1988 see column 7, line 12 - line 23; claim 4; figures 2,3	1
X	PATENT ABSTRACTS OF JAPAN vol. 10 no. 268 (E-436) ,12 September 1986 & JP,A,61 093552 (MATSUSHITA ELECTRIC WORKS) 12 May 1986, see abstract	1
X	PATENT ABSTRACTS OF JAPAN vol. 9 no. 61 (E-303) ,19 March 1985 & JP,A,59 198655 (MATSUSHITA DENKO K.K.) 10 November 1984, see abstract	1
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